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EXXON COMPANY, U.S.A.'s

Energy Outlook 1980-2000

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Introduction

This booklet presents Exxon's assessment of the U.S. energy environment for the period 1980-2000. It updates the December 1979 Outlook and is expanded to portray the relationship between energy sources and their end uses. Specifically, the need for energy in liquid form is compared with prospects for conventional oil and synthetic fuels production. Also, this booklet includes a discussion of the contribution of renewable energy sources.

The projections which follow reflect our best judgment of the impact of economic, environmental, technical, and governmental factors which affect the nation's energy future. As these factors and our perception of them change, so may the details of this Outlook.

Note: Most graphs are scaled in millions of barrels per day of oil equivalent (MMB/DOE), a measurement that can be applied to all forms of energy based on their heat content relative to that of oil (5.55 million BTUs = 1 barrel of oil).

Basic Assumptions

The projections in this Outlook are based on the following specific assumptions regarding future conditions affecting world and U.S. energy supply and demand.

Government Energy Policy. Government energy policy will permit economic growth by establishing a balance among energy, economic, and environmental goals. Domestic crude oil prices will achieve parity with world oil prices during 1981. Middle East crude oil prices are assumed to rise by 50% in real terms between 1980 and 2000. Natural gas prices will be governed by the Natural Gas Policy Act of 1978.

The Economy. Real GNP is projected to grow at an average annual rate of about 2.6% through 2000. This compares with 4.1% per year over the 1960-73 period and 2.0% annually from 1973 through 1980.

The Environment. Environmental goals will be achieved at a rate compatible with economic growth. In certain cases, there will continue to be some accommodation of compliance deadlines when the alternative is to shut down major existing facilities. Moreover, environmental policies will not prohibit the construction of major new facilities inherent in the projections of future economic and energy growth.

Oil Imports. To supply the needs of the U.S., increasing imports from the nations affiliated with the Organization of Petroleum Exporting Countries (OPEC) will be required during the 1980s. It is assumed that international energy trade will not be hampered by economic instability or lack of international cooperation. Total world conventional oil production is projected to rise slowly, increasing from 65 MMB/D in 1980 to 71 MMB/D by the turn of the century.

Total U.S. energy demand is projected to grow at a rate of 0.7% annually in the years 1980-90. This rises to 1.2% per year in the 1990-2000 period, largely because of energy required for synthetic fuels production and a decline in the rate of fuel efficiency improvement.

Demand by Sector (MMB/DOE)

	1960	1980	1990	2000
Nonenergy	1.9	3.2	3.7	4.2
Industrial	8.0	12.7	14.2	18.2
Res./Comm.	6.6	12.6	13.4	13.7
Transp.	5.4	9.4	9.2	9.4
Total	21.9	37.9	40.5	45.5

Energy demand in the **Transportation** sector will decline through 1990, then grow modestly to the end of the century. This sector is almost entirely dependent on oil and will account for over half the total oil consumed through the year 2000.

Demand in the **Residential/Commercial** sector, which consists chiefly of private and public buildings, is expected to grow at lower than historic rates, due primarily to more efficient energy use and a lower rate of household formation.

In the **Industrial** sector, made up principally of all mining and manufacturing industries, demand will increase through 2000, as expansion of industrial activity is only partially offset by conservation efforts. Energy required for synthetic fuels production is a major factor in the higher growth rate in the 1990s.

Consumers in the **Nonenergy** sector use oil, gas and metallurgical coal as feedstock or raw material, rather than as fuel. Demand grows in this sector at a less than historic rate due to slower economic growth and higher costs for these raw materials.

Due in large part to **Conservation,** energy demand is expected to grow at a rate significantly lower than that experienced in the 13-year period prior to the Arab oil embargo of 1973. If future energy prices and consumption patterns were to follow the trends of that period, energy demand in the year 2000 would reach about 70 MMB/DOE, as indicated by the broken line on the chart below. Instead, conservation will have the effect of reducing demand over the entire period.

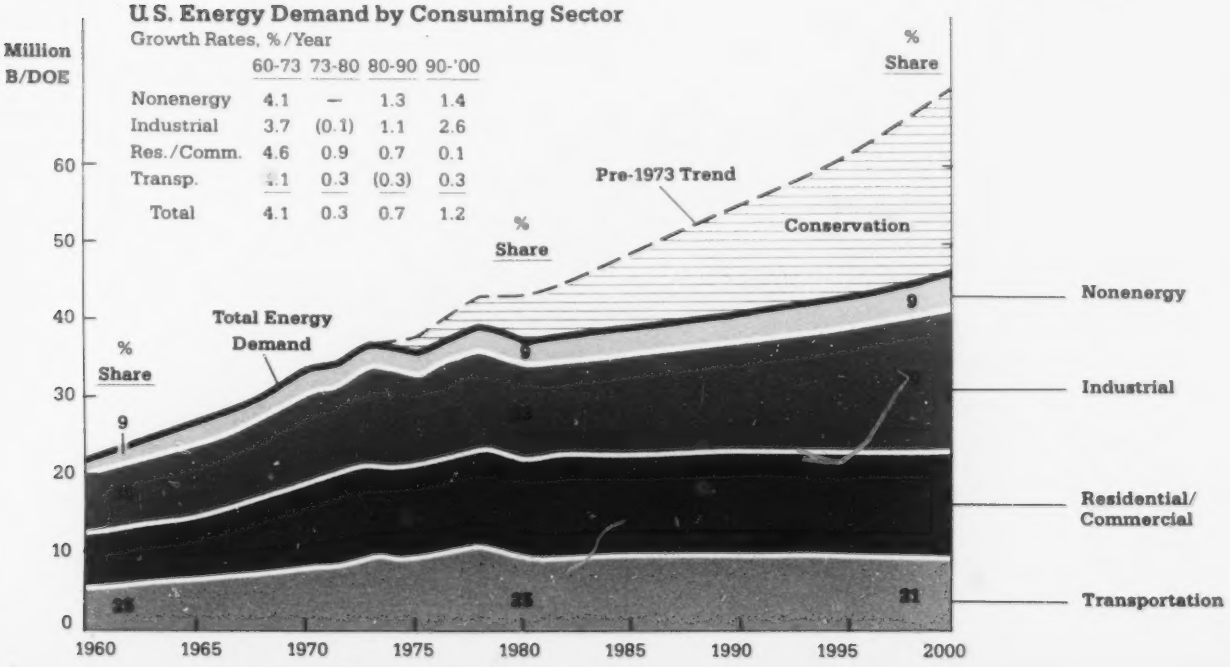
Conservation: Projected demand reduction by sector vs. pre-1973 trend (%)

	1980	1990	2000
Industrial/ Nonenergy	12	20	23
Res./Comm.	13	22	34
Transportation	12	39	52
Overall	12	26	34

In the **Transportation** sector, demand reduction results primarily from improved automotive efficiency. Efficiency improvements are also expected in other forms of transportation.

Demand reduction in the **Residential/Commercial** sector reflects actions such as adjusted thermostat settings and more efficient heating, appliances, and structures.

In the **Industrial/Nonenergy** sectors, savings result from better energy management, the retrofitting of industrial equipment, and the development of new, less energy intensive processes.



Note: Electrical losses are allocated to each sector.

Significant changes are projected in the U.S. energy "mix" over the Outlook period. Coal and nuclear will provide growing shares of total energy, while the contribution of gas and oil declines. Nevertheless, oil will provide the largest share of total energy through the end of the century. Each energy source will be examined in greater detail later, but an overview is provided here.

Demand by Fuel Consumed (MMB/DOE)

	1960	1980	1990	2000
Hydro, Geo, Solar	0.8	1.6	2.3	2.7
Nuclear	—	1.4	3.2	4.9
Coal	4.8	7.8	10.0	14.1
Gas	6.5	10.2	8.8	8.5
Oil	9.8	16.9	16.2	15.3
Total	21.9	37.9	40.5	45.5

Hydro, Geothermal and Solar combined are estimated to supply 4-6% of total U.S. energy requirements over the Outlook period. The growth potential for hydro and geothermal is limited because of site availability. While solar has significant potential, technological improvements are required to reduce equipment costs.

Nuclear energy is confined to electric utility use. While nuclear's development continues to be slowed by construction, regulatory and siting delays, its share of total energy supply is expected to grow from 4% in 1980 to 11% in 2000.

U.S. **Coal** use will increase substantially over the Outlook period. Direct coal burning and coal consumed in the process of producing synthetic fuels are shown as coal demand on this page. The liquid and gas output of coal synthetics plants is included in the oil and gas statistics. U.S. coal resources and the capacity to develop them are more than adequate to meet projected demand, assuming reasonable coal mining regulations.

The absolute volume of **Gas** consumed declines from 10.2 MMB/DOE to 8.5 MMB/DOE over the Outlook period. The share of gas in total energy demand also declines. Domestic conventional gas supplies are expected to be supplemented from other sources, including overland gas imports, synthetic gas manufactured from coal, and imported liquefied natural gas (LNG).

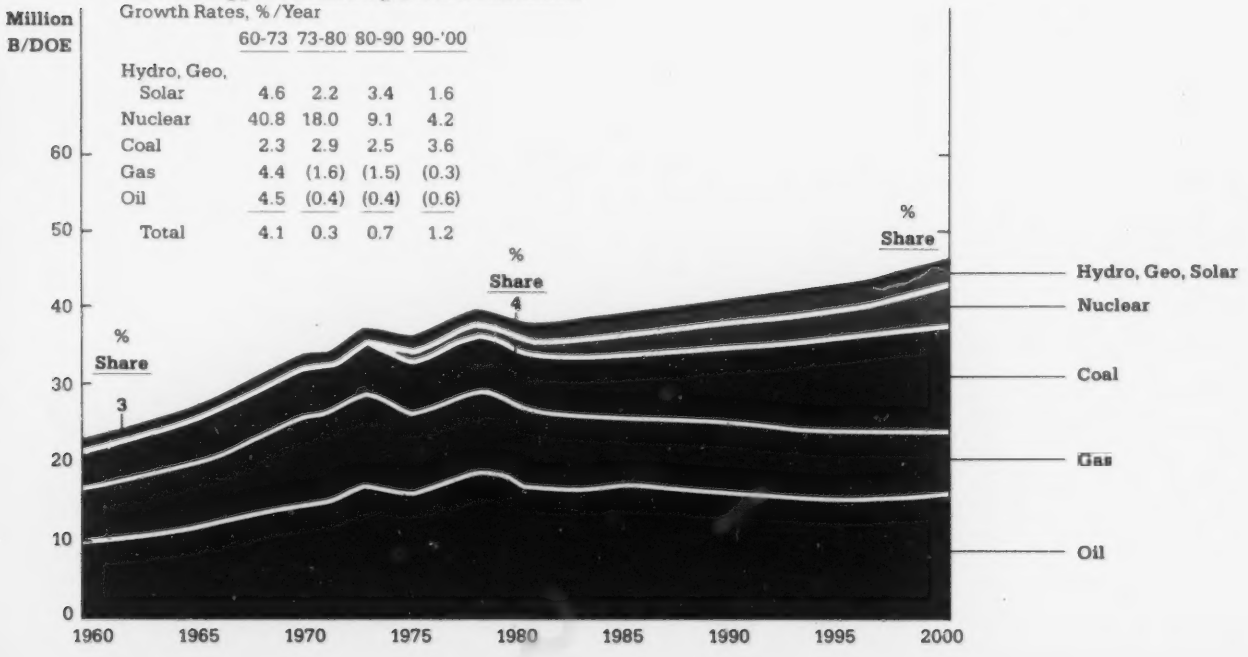
While **Oil's** share of total energy supply declines from 44% in 1980 to 33% in 2000, it remains the largest energy source through the end of the century.

The critical role of oil is examined in detail in the next two sections.

U.S. Energy Demand by Fuel Consumed

Growth Rates, %/Year

	60-73	73-80	80-90	90-'00
Hydro, Geo, Solar	4.6	2.2	3.4	1.6
Nuclear	40.8	18.0	9.1	4.2
Coal	2.3	2.9	2.5	3.6
Gas	4.4	(1.6)	(1.5)	(0.3)
Oil	4.5	(0.4)	(0.4)	(0.6)
Total	4.1	0.3	0.7	1.2



Oil demand declines over the Outlook period, principally because of conservation and the substitution of other fuels in end uses where oil has historically been consumed. Oil remains the critical fuel because of its versatility and economic and technical limitations on the use of other fuels.

Oil **Conservation** is already occurring and is expected to accelerate over the forecast period. A major contributor to conservation is increased automobile efficiency. Current law mandates an improvement in new automobile gasoline mileage of about one-third by 1985 relative to the automobiles sold in 1980. This Outlook assumes that further technological development will increase automobile efficiency significantly by 2000.

Like conservation, **Substitution** is a relatively recent phenomenon. Prior to the Arab oil embargo of 1973-74, there was little incentive to substitute other energy sources for oil. In the last decade, however, the twin concerns of price and availability of supplies have brought about increasing substitution for oil. By the year 2000, only 8% of oil demand will be for uses in which other energy sources could readily be substituted.

In the **Residential/Commercial** area, conservation and substitution combined will halve oil consumption by 2000. Conservation steps include additional insulation, more efficient furnaces, and lower thermostat settings. Additionally, electricity, gas, and solar will increasingly be used for space and water heating.

Demand by Sector (MMB/D)

	1960	1980	1990	2000
Transp.	5.4	9.4	9.1	9.3
Nonenergy	0.8	2.2	2.7	2.9
Industrial	1.3	2.1	2.1	1.8
Electricity	0.2	1.1	0.7	0.4
Res./Comm.	2.1	2.1	1.6	0.9
Exports/ Other	0.2	0.6	0.6	0.6
Total	10.0	17.5	16.8	15.9

Another large area of potential substitution for oil is **Electricity** generation. Presently, two-thirds of oil consumption in this sector occurs in base-load operations, for which coal and nuclear energy are economic alternatives. As a result of substitution of coal and nuclear, by 2000 essentially all of the oil consumed will be for intermittent operation, where coal and nuclear are not practical.

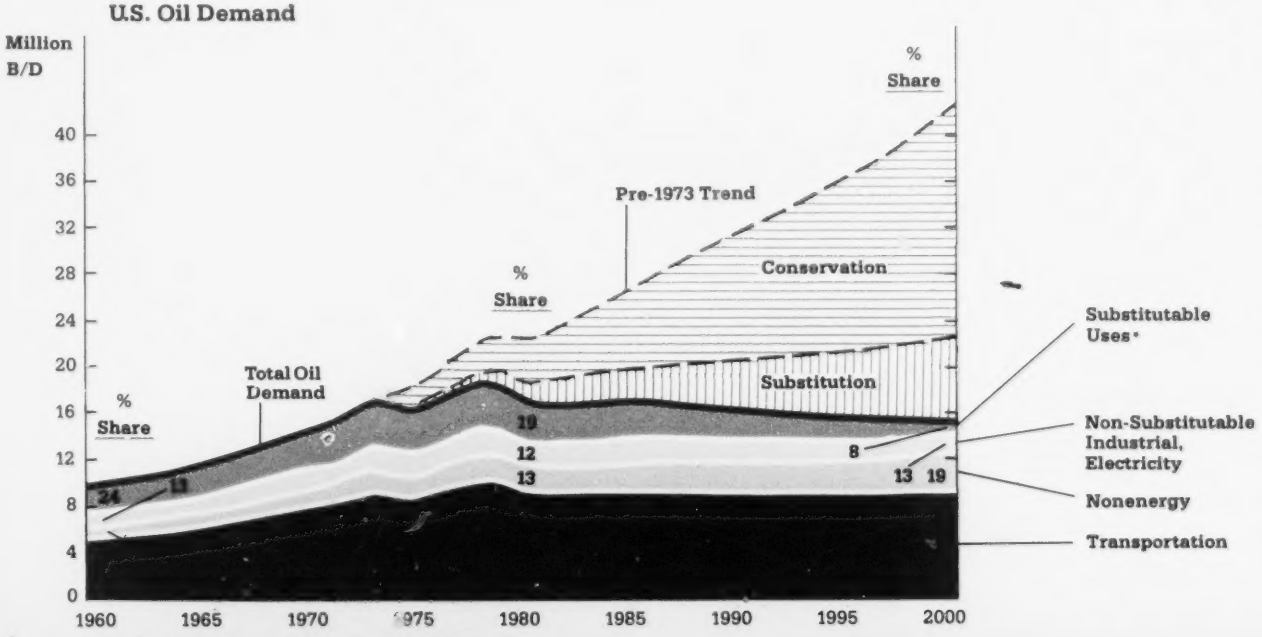
In the **Industrial** sector, coal and electricity will replace oil where feasible. Certain industrial uses, such as off-highway vehicles and small boilers for which gas is unavailable, will still require oil. Substitution and conservation combined will reduce oil use slightly over this period, even though projected economic growth will increase industrial energy demand by 43%.

Large-scale substitution for oil in **Transportation** is not practical for economic and technological reasons. The most likely form of substitution will be electricity. Electric automobiles and light trucks with a limited range are projected to be introduced into the market in the mid-1980s and to increase their penetration to 10% of new car and light truck sales in 2000. There will also be a growing use of electricity by railroads. Nevertheless, in 2000, 99% of the energy requirements of this sector are estimated to be met by oil.

Substitution is also limited in the **Nonenergy** sector. While there is the potential to substitute natural or synthetic gas in the manufacture of petrochemicals, oil use (including natural gas liquids) in this sector is expected to increase as a result of economic growth.

In sum, by the end of the century, nearly all economically and technologically feasible conservation and substitution steps will have been taken. This will permit economic growth to occur even as oil consumption declines. Nonetheless, oil demand will be only 9% lower than it is today.

U.S. Oil Demand



* Industrial, Residential/Commercial, Electricity

In 1980, U.S. oil supply consisted of 10.6 MMB/D (61%) from domestic sources and imports totalling 6.9 MMB/D (39%).

Oil Supply (MMB/D)

	1960	1980	1990	2000
Existing Reserves	8.0	10.1	5.8	3.8
Other Supplies	0.2	0.5	0.2	0.2
New Discoveries	—	—	1.1	3.8
Synthetics	—	—	0.9	3.4
Imports	1.8	6.9	8.8	4.7
Total	10.0	17.5	16.8	15.9

Domestic Oil Production peaked in the early 1970s and is declining. This decline has been slowed by the advent of North Slope oil, which began flowing through the trans-Alaska pipeline in 1977 and contributed 1.5 MMB/D in 1980. In addition, intensive efforts — such as well workovers and secondary recovery — aimed at maximizing production from existing fields have also slowed the decline. In the future, tertiary recovery projects will become increasingly important in domestic oil production. Nonetheless, supply from existing reserves is projected to decline to 3.8 MMB/D in 2000. Other supplies consist primarily of expansion during the refining process offset by crude consumed in field production.

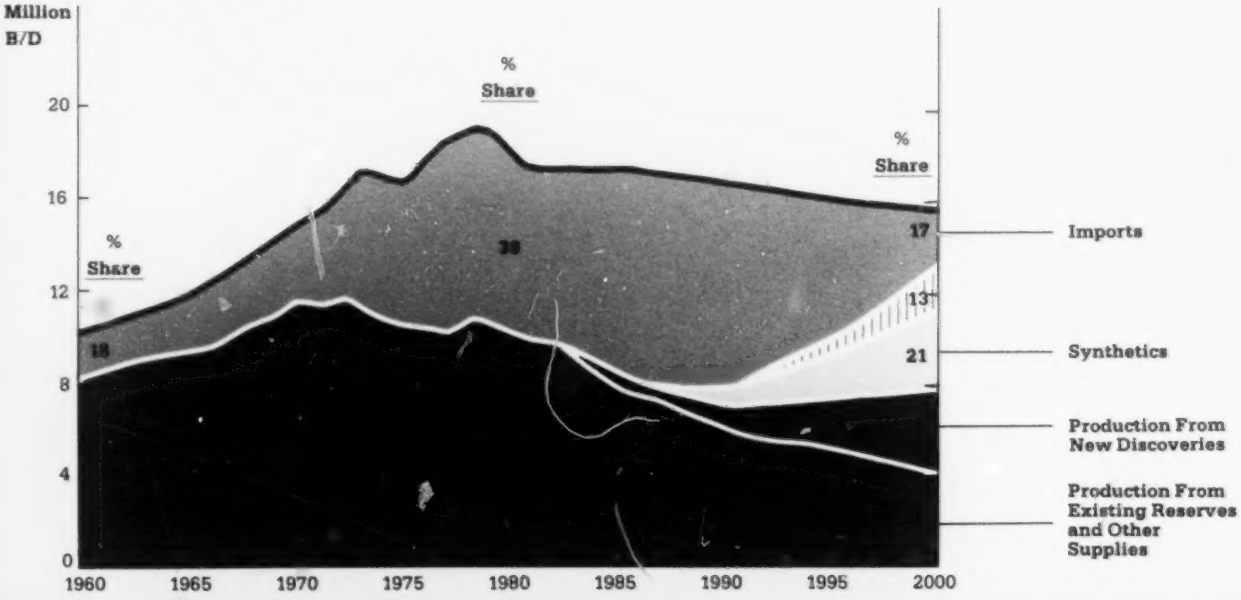
To supplement production from known fields, an extensive effort will be required to find and develop new oil reserves. Because lead times in some areas are eight to 11 years between initial exploration and first production, most of the impact of this effort will occur in 1990 and beyond, with production reaching 3.8 MMB/D by 2000. To illustrate the magnitude of the required effort and investment, the projected year 2000 production level is the equivalent of 2½ times the current production from the Alaskan North Slope. Most of the new reserves are likely to be found in Alaska and on the Outer Continental Shelf (OCS), areas where access is subject to government leasing and regulatory policy. Due to the lead times involved, rapid exploration to determine the resource potential of the OCS is essential.

Synthetic Liquids from coal and oil shale will become commercially available by the mid-80s and will become an important supplement to conventional oil production. These synthetics could account for up to 34% of U.S. oil supply in the year 2000, depending upon how rapidly a national synthetic fuels industry is established and production capacity placed in operation. The range of projected synthetic liquids production is shown as the lined area on the chart. Synthetic fuels development is discussed on Page 15.

Remaining oil needs must be met by **Imports,** the bulk of which will continue to come from members of the Organization of Petroleum Exporting Countries. Oil imports are projected to increase from the 1980 level of 6.9 MMB/D, about 39% of total supply, to about 8.8 MMB/D in 1990, about 52% of total supply in that year. By 2000, oil imports will decline to between 17 and 30% of that year's supply, depending on the level of synthetic liquids production.

Serious questions remain over the Outlook period concerning the price and supply reliability of imports. If production of newly discovered oil or synthetic liquids does not reach the projected levels, the potential for reducing oil imports during the 1990s would be limited. Should imports not be available as needed, the U.S. would experience lower real economic growth and be subject to higher-than-projected world oil prices.

U.S. Oil Supply



Note: Scale expanded to show detail.

U.S. Electric Utility Demand By Consuming Sector

Energy consumption in the form of electricity can be measured in two ways: the amount of energy used to generate electricity and the amount of energy electricity provides in its various end uses. The difference between these two measures (about 70%) is the energy consumed, or "lost," in the process of generating and transmitting electricity. The chart below shows energy used as electricity by consuming sectors, as well as energy consumed in the process of generation and transmission. (Note: The chart on Page 4 allocates "losses" to the consuming sectors in proportion to their electricity use.)

Demand by Sector (MMB/DOE)

	1960	1980	1990	2000
Gen./Trans. Losses	2.8	8.4	9.8	11.7
Industrial	0.6	1.5	1.8	2.3
Transp.	—	—	—	0.1
Res./Comm.	0.6	2.1	2.4	2.7
Total	4.0	12.0	14.0	16.8

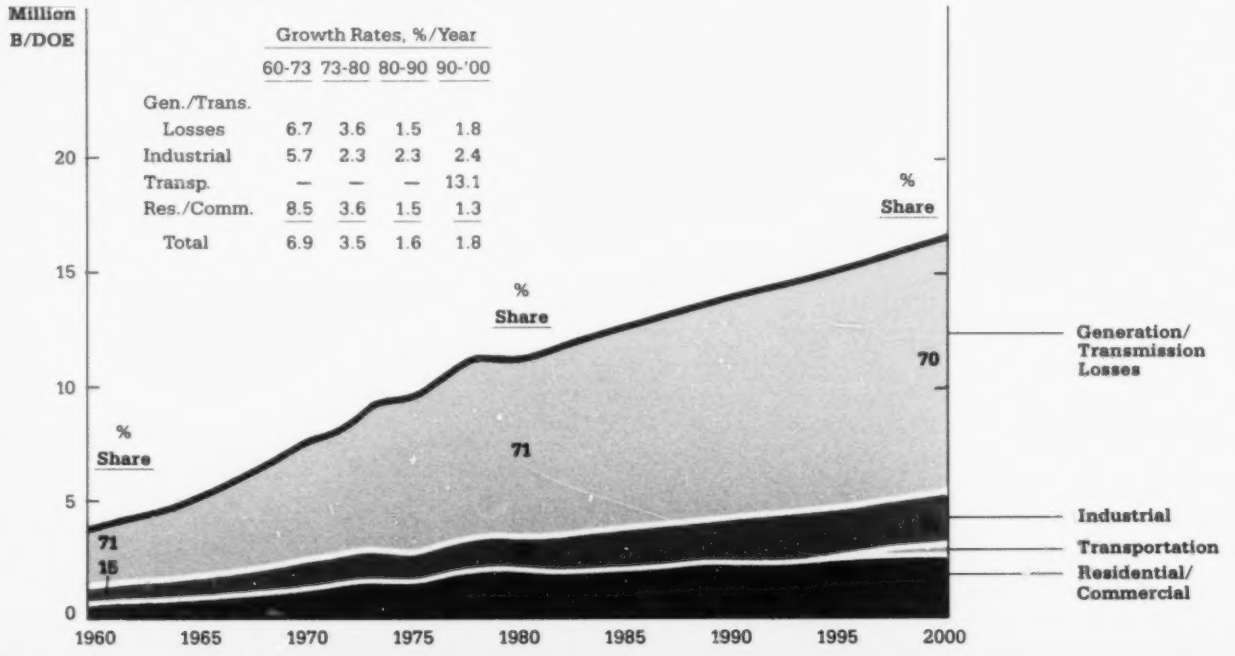
Measured by amounts used in consuming sectors, electricity meets about 9% of total energy demand. This share grows to about 10% by 1990 and 11% by 2000, largely due to the previously discussed substitution of electricity for oil in end uses.

Electricity use in the **Residential/Commercial** sector will increase from 2.1 MMB/DOE in 1980 to 2.7 MMB/DOE in 2000, as an increasing number of new homes use electricity for space and water heating.

The **Transportation** sector, where opportunities for substituting electricity for oil are severely limited, will account for less than 1% of electricity use by the end of the Outlook period.

Demand in the **Industrial** sector will rise by more than 50% over the Outlook period, from 1.5 MMB/DOE in 1980 to 2.3 MMB/DOE in 2000. The potential for industrial conservation is less for electricity than for other fuels.

U.S. Electric Utility Demand By Consuming Sector



On an input basis, electric utilities today account for about 32% of all energy consumed in the U.S. This share grows to 37% by 2000.

Demand by Fuel Consumed (MMB/DOE)

	1960	1980	1990	2000
Oil	0.2	1.1	0.7	0.4
Gas	0.9	1.9	1.0	0.5
Nuclear	—	1.4	3.2	4.9
Coal	2.1	6.0	6.8	8.4
Geothermal / Other	—	—	0.1	0.2
Hydro	0.8	1.6	2.2	2.4
Total	4.0	12.0	14.0	16.8

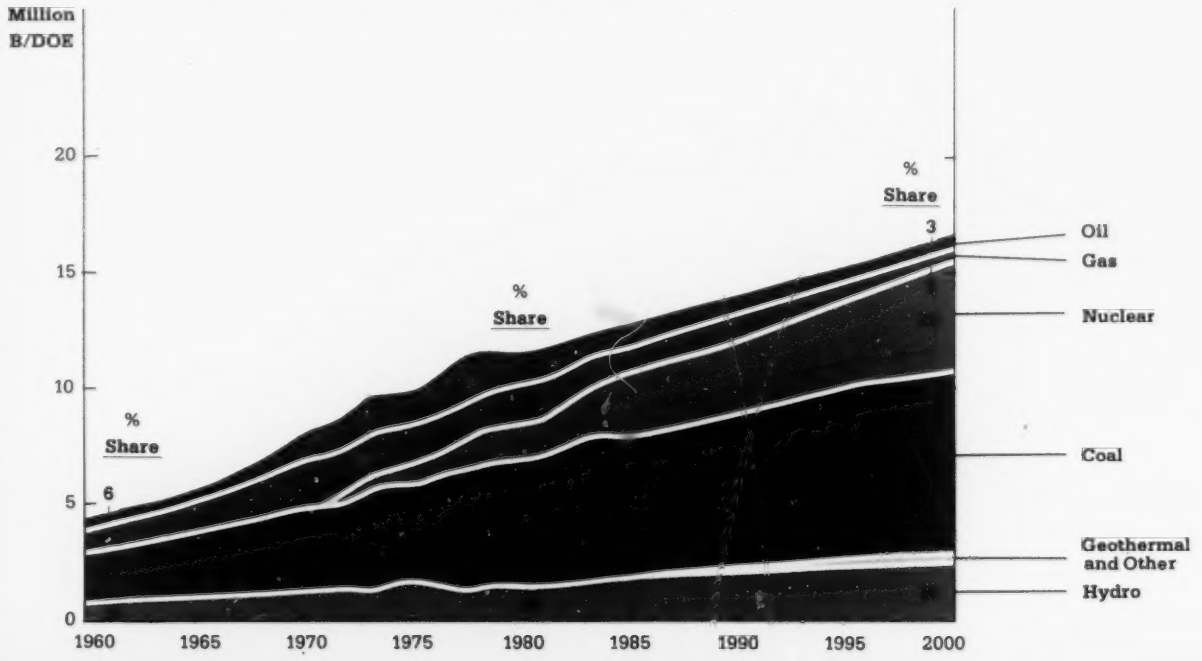
The potential growth in **Hydro** and **Geothermal** is relatively small and, as mentioned earlier, is limited by site availability. Hydro will meet about 14% of utility demand throughout the Outlook period. By 2000, geothermal's share will rise to about 1%.

Coal is projected to continue as the major utility fuel, supplying about half of utility demand through the Outlook period. **Gas** consumption by utilities will decline due to decreasing supply and the low priority of utilities as gas consumers.

As discussed in the Oil Demand section, coal and nuclear will be increasingly substituted for oil in electricity generation. **Oil's** share declines sharply, from about 9% of utility demand in 1980 to slightly less than 3% by the end of the century.

By 2000, **Nuclear** is projected to supply 29% of U.S. electric utility demand, compared with 11% in 1980. Environmental and safety concerns, as well as lower electricity demand projections, have continued to retard the growth of nuclear capacity. The ordering rate for new nuclear plants declined sharply in the mid-1970s, and no new plants have been placed on order since 1978. The projections in this Outlook require that approximately 6,000 megawatts of nuclear capacity a year be brought on line. While the reactors projected to be in operation through 1990 are currently either under construction or on order, the Outlook projections assume a resumption of plant orders in the 1980s to meet growing electricity demand in the 1990s.

U.S. Electric Utility Demand By Fuel Consumed



U.S. Gas Demand

Total demand for natural gas is projected to decline at a rate of about 1% annually, from 20 trillion cubic feet per year (tcf/yr.) in 1980 to 16.7 tcf/yr. in 2000.

Demand by Sector (trillion cubic feet/year)

	1960	1980	1990	2000
Electricity Generation	1.7	3.8	2.0	1.1
Industrial/ Nonenergy	7.2	9.5	8.2	9.3
Res./Comm.	4.1	6.7	7.1	6.3
Total	13.0	20.0	17.3	16.7

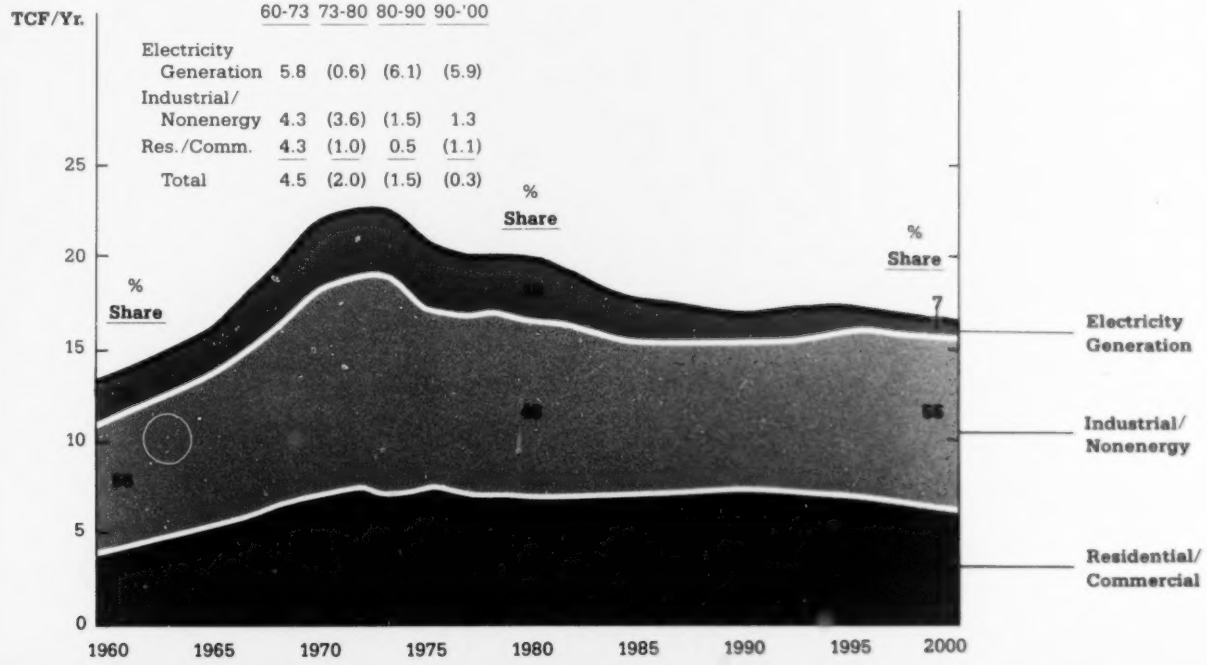
The use of gas in **Electricity Generation** will show the sharpest drop, as utilities use more coal and nuclear energy. Demand in this sector falls from 3.8 tcf/yr. in 1980 to 1.1 tcf/yr. in 2000.

Gas demand in the **Industrial/ Nonenergy** sector is projected to decline through 1990, then grow at about 1.3% annually over the remainder of the Outlook period. Much of this growth will occur in the nonenergy segment, where synthetic gas is expected to become a feedstock for certain petrochemical uses. Gas supplies to industrial users will rise modestly over the 1990-2000 period.

Residential/Commercial demand for gas is expected to fall from 6.7 tcf in 1980 to 6.3 tcf in 2000. Gas use will decline as users practice conservation and turn to electricity, which, in applications such as heat pumps, will offer an economically attractive alternative to gas.

U.S. Gas Demand

	Growth Rates, %/Year			
	60-73	73-80	80-90	90-'00
Electricity Generation	5.8	(0.6)	(6.1)	(5.9)
Industrial/ Nonenergy	4.3	(3.6)	(1.5)	1.3
Res./Comm.	4.3	(1.0)	0.5	(1.1)
Total	4.5	(2.0)	(1.5)	(0.3)



U.S. Gas Supply

U.S. natural gas production has been declining since 1973, when it peaked at 22 tcf/yr. This decline is expected to continue; by the year 2000, production is expected to drop to 14.1 tcf/yr.

U.S. Gas Supply
(trillion cubic feet/year)

	1960	1980	1990	2000
Existing Reserves	12.8	18.8	10.2	6.7
New Discoveries	—	—	4.4	7.4
Synthetics	—	0.2	0.8	1.6
Imports	0.2	1.0	1.9	1.0
Total	13.0	20.0	17.3	16.7

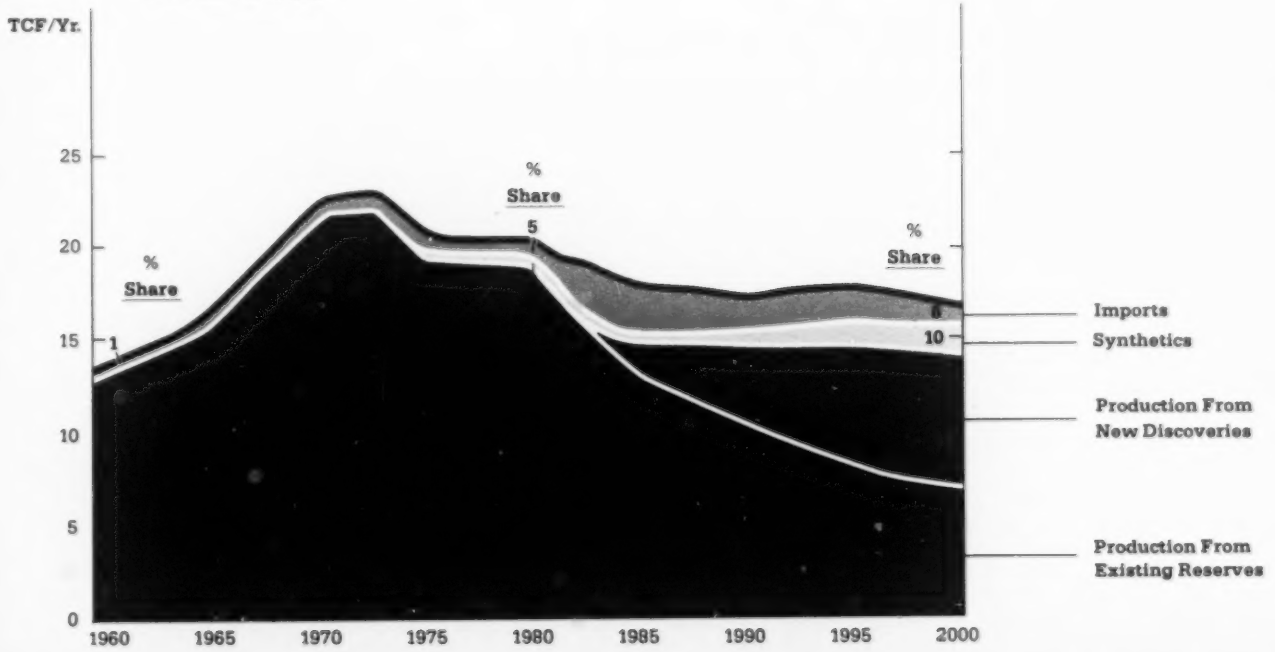
Gas production on Alaska's North Slope is expected to start in the mid-1980s and will provide about 5% of total U.S. production by 1990. About 30% of **Domestic Gas Production** in 1990, and more than half of that in 2000, must come from reserves yet to be discovered. The lower 48 states, both inland and offshore, will continue to play a key role in future gas discoveries.

Access to the Outer Continental Shelf (OCS) is dependent on government policies and has a direct bearing on future offshore production levels. Rapid exploration of the petroleum resource potential of the OCS is essential if the projected level of production from new discoveries is to be reached.

About 0.2 tcf of **Synthetic Gas** per year are currently produced by reforming naphtha and liquefied petroleum gas. Synthetic gas from coal is projected to be commercially available beginning in the late 1980s. Total annual synthetic gas production could reach 0.8 tcf by 1990. By 2000, the outlook is for synthetic gas production to reach a level of 1.6 tcf, or nearly 10% of total supply. However, if this projection of synthetic gas production is not met, additional oil or gas imports may be required.

Imports of gas are projected to increase from 1.0 tcf in 1980 to 1.9 tcf in 1990, then decline to 1.0 tcf by 2000. Pipeline imports from Canada and Mexico are expected to supply 65% of the gas imports in 1990 and 70% in 2000. The remainder will be imports of liquefied natural gas (LNG).

U.S. Gas Supply



U.S. Coal Demand

Demand for U.S. coal will rise significantly over the Outlook period, from 832 million tons in 1980 to 1.2 billion tons in 1990, and 1.9 billion tons in 2000. This represents an average annual growth rate over the Outlook period of 4.3%. Much of this growth is attributable to the production of synthetic fuels from coal and the use of coal in applications now utilizing other energy sources.

Demand by Sector
(million short tons/year)

	1960	1980	1990	2000
Exports/ Other	36	108	107	159
Synthetics	—	—	125	511
Gen. Ind./ Nonenergy	181	150	208	305
Electric Utility	177	570	693	910
Res./Comm.	40	4	22	31
Total	434	832	1,155	1,916

The **Electric Utility** industry will remain the largest user of coal, accounting for just under half of all U.S. coal demand by the end of the century. Coal use in this sector will rise by 60% over the Outlook period.

Coal demand in the **General Industrial** and **Nonenergy** sectors will more than double, rising from 150 million tons in 1980 to 305 million tons by 2000.

After 1985, the **Synthetic Fuels** industry will consume growing amounts of coal, for both energy and use as feedstock. Coal used in the production of synthetic liquids and gas will account for 11% of demand in 1990 and 27% in 2000.

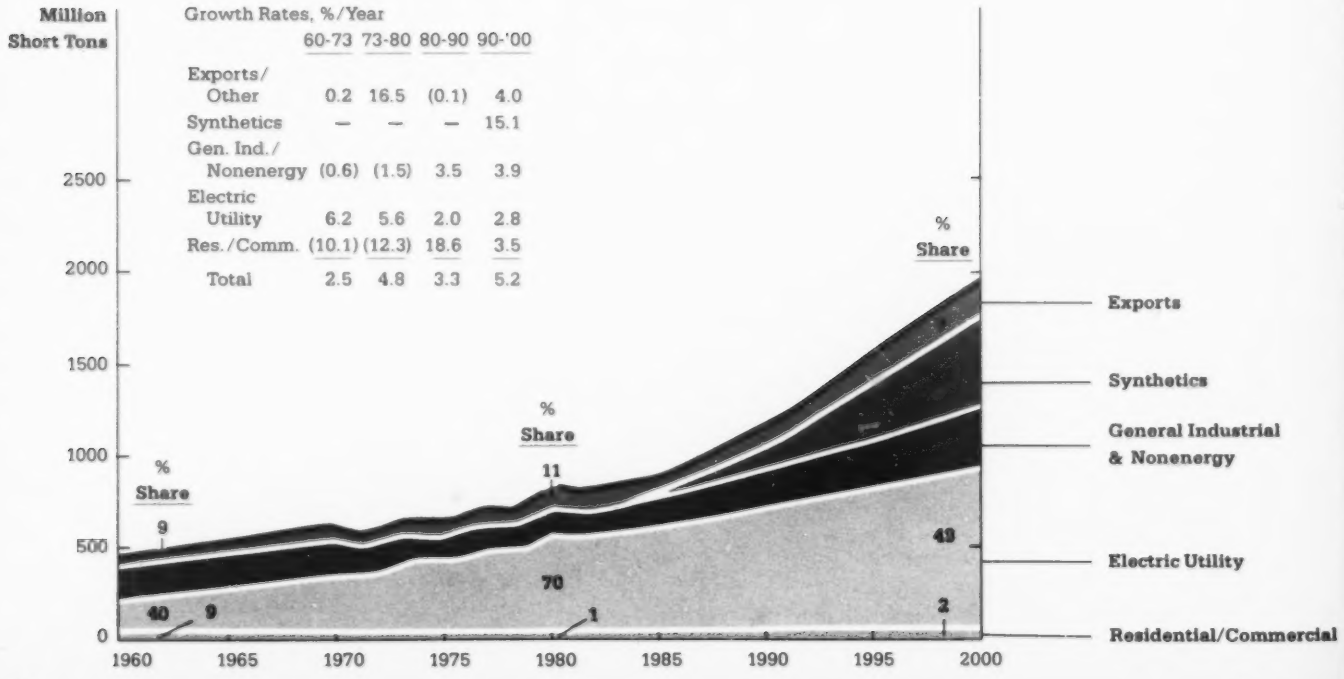
The **Residential/Commercial** use of coal will remain minimal at about 1-2% of total demand over the Outlook period.

Coal **Exports** are projected to increase over the Outlook period. Metallurgical coal made up about 70% of 1980 coal exports. However, rising consumption of U.S. steam coal by European industry and electric utilities is expected in the 1990s. Export levels will in large part be dependent upon the economics of U.S. coal relative to other available energy sources.

U.S. Coal Demand

Growth Rates, %/Year

	60-73	73-80	80-90	90-'00
Exports/ Other	0.2	16.5	(0.1)	4.0
Synthetics	—	—	—	15.1
Gen. Ind./ Nonenergy	(0.6)	(1.5)	3.5	3.9
Electric Utility	6.2	5.6	2.0	2.8
Res./Comm.	(10.1)	(12.3)	18.6	3.5
Total	2.5	4.8	3.3	5.2



Annual coal production will more than double over the Outlook period.

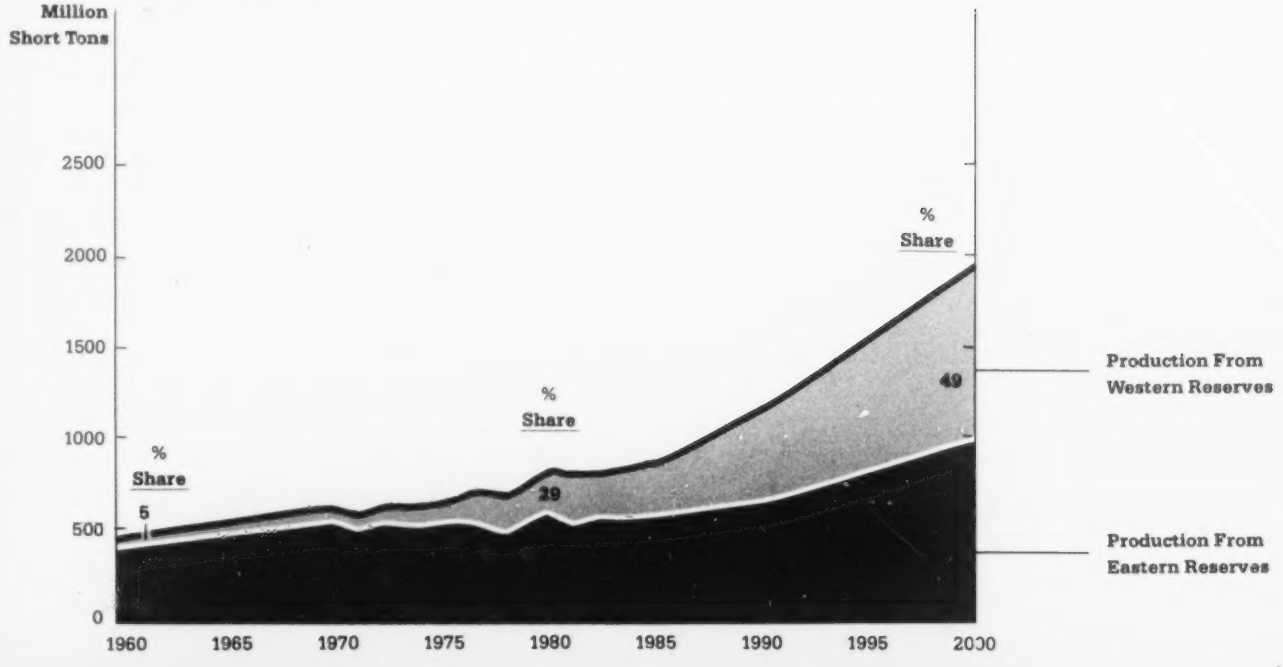
U.S. Coal Supply — domestic production (million short tons/year)

	1960	1980	1990	2000
Eastern Reserves	413	587	657	974
Western Reserves	21	245	498	942
Total	434	832	1,155	1,916

Eastern Coal. Coal fields east of the Mississippi River have historically provided the bulk of domestic output, but production from existing mines has been declining. Most future production in this area must come from deeper, more expensive mines. However, the higher costs will be offset by the fact that Eastern coal is close to established markets and is readily accessible to existing transportation systems. Eastern coal, which typically is high in sulfur content and BTUs, is expected to supply about 57% of U.S. coal demand in 1990 and about 51% in 2000, compared with 71% in the year 1980.

Western Coal. Much of the growth in coal supply is projected to come from surface mining of Western coal, which generally contains less sulfur and BTUs than Eastern coal. Western coal is expected to provide 43% of domestic production in 1990, and 49% in 2000, compared with 29% in 1980.

U.S. Coal Supply



Renewable fuels such as hydro, geothermal, solar, biomass, and wind are expected to play an important role in meeting long-term U.S. energy needs. The contribution of renewables (including wood, which is included on this page, but not elsewhere in this Outlook) will be growing over the Outlook period to about 6-8% of total energy supply by the year 2000.

Renewable Energy Sources
MMB/DOE

	1980	1990	2000
Biomass	0.62	0.95	1.16
Solar	—	0.03	0.17
Geothermal/ Wind	0.03	0.06	0.14
Hydro	1.62	2.21	2.37
Total	2.27	3.25	3.84

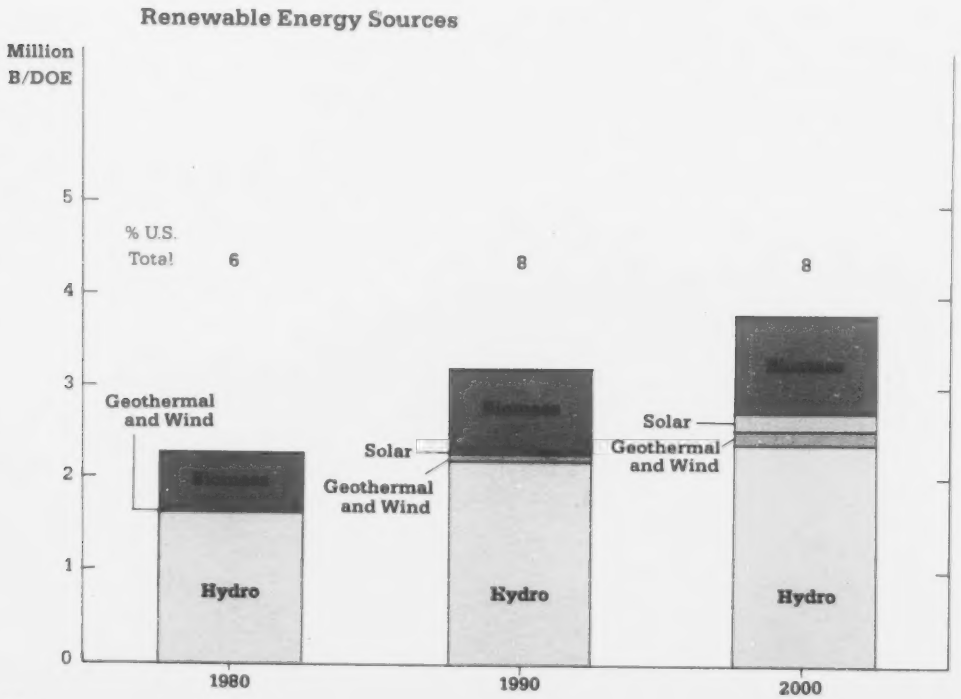
Growth in **Hydro** and **Geothermal/ Wind** is limited by site availability and technology. Hydro will rise to 2.37 MMB/DOE in 2000, as new hydroelectric generating equipment is installed where economically feasible. Potential sites include present hydroelectric facilities, as well as smaller, "low-head" dams not currently used for generating electricity. Geothermal, which produced less than 30,000 B/DOE in 1980, will rise to 114,000 B/DOE in 2000. The use of wind for producing electricity is negligible at present, but is expected to grow to about 20% of the geothermal/ wind total as new windmill designs become commercial.

Solar offers significant potential for the future, but its growth is presently inhibited by high costs. Technological breakthroughs eventually may bring costs down, but even after the breakthroughs occur, it will take decades to apply the new technology widely enough to meet a significant share of energy demand. In this Outlook, solar energy is projected to contribute 170,000 B/DOE in 2000, mostly for water and space heating.

Most of the **Biomass** energy shown below is attributable to the burning of wood by the forest products industry to produce steam. This use of wood as a direct substitute for coal, oil, and gas is expected to grow as the industry burns more waste materials and modifies or replaces plant equipment utilizing other energy forms. Small quantities of liquid fuel are now being provided by ethanol, an alcohol made from grain or other crops and then blended with gasoline to form gasohol. Ethanol is more costly than conventional oil or synthetic fuels that can be derived from oil shale or coal, although this fact is masked by tax exemptions and other subsidies. Energy from biomass is projected to rise to 1.2 MMB/DOE in 2000.

Nuclear Fusion, regarded by many as a nondepleting energy source, ultimately may add dramatically to the already substantial potential of nuclear technology to provide electricity. But fusion is still in the research and development stage, and commercial demonstration is unlikely before the year 2000.

While renewable energy sources will become increasingly available over the Outlook period and will, in some cases, be used in place of oil, they are not projected to contribute significantly to the nation's critical liquid energy supply/demand balance.



Synthetic fuels offer the U.S. an opportunity to reduce its reliance on imported oil and gas. The volumes of synthetic fuels contained in this Outlook are feasible. The U.S. has abundant reserves of coal and oil shale, the processing technology is sufficiently developed to begin commercial production, and the required capital investments are large but manageable. As shown on the chart, the Energy Security Act has set national production goals of 0.5 MMB/DOE of synthetic liquids and gas by 1987 and 2.0 MMB/DOE by 1992. The production levels envisioned in this Outlook are consistent with these targets, and the 6 MMB/DOE production level in 2000 shown here is achievable if the nation chooses to take advantage of its synthetics potential.

In order for these production levels to be achieved, the design and construction of additional synthetic fuels plants must be in progress before the first facilities begin to produce. Such a parallel development program is necessary because a lead time of approximately eight years (three to four years of planning and design work followed by four to five years of construction and related activity) is required to bring a plant on stream. For example, the chart shows that in 1987, when production is projected to be only 0.4 MMB/DOE, an additional 3.1 MMB/DOE capacity must be in various stages of planning, design and construction.

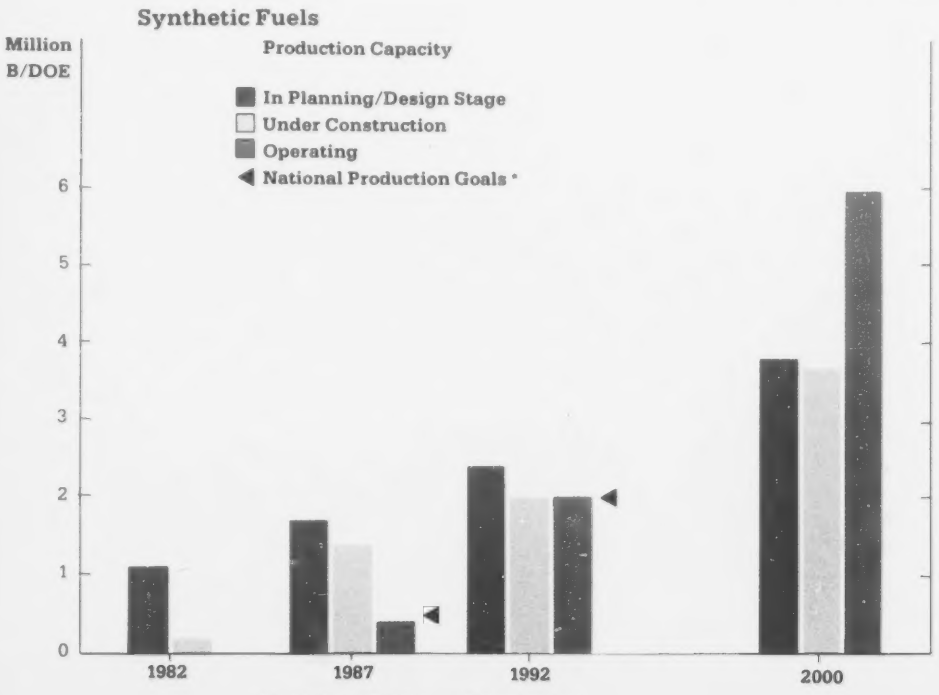
In addition to the development of the initial synthetics plants, the challenge for the immediate future is to address critical policy issues so that required design and construction work for future plants will not be delayed. Decisions reached in the early 1980s concerning resource leasing, environmental matters, water supplies, and socioeconomic impacts will in large measure determine the ability to expand synthetic fuel production in the 1990s.

The federal government, which controls the vast majority of oil shale and coal resources in the West, should develop a leasing program consistent with synthetic fuel production objectives.

The environmental questions associated with a large-scale synthetics industry must be addressed in a comprehensive manner. The pollution control technology employed in early plants will meet all existing environmental requirements, and improved technology is likely to be available for subsequent facilities.

While studies suggest that water from local sources will be sufficient to supply early synthetic fuel facilities, interbasin water transfers will likely be required to permit projected industry development in the late 1990s. Sufficient water supplies exist, and moving them to where they are needed is physically and financially feasible. Careful planning and the involvement of government at all levels will be required.

The social and economic impacts of such a large, fast-growing industry will be significant. Transportation systems, housing, schools, health-care facilities, and other essentials needed by thousands of workers and their families must be developed.



U.S. Energy Policy Implications

This Outlook shows the nation in a period of transition from a petroleum-dependent economy to one based on a diversity of energy sources. Ultimately, the entire world will move to reliance on nondepleting or renewable energy sources. For the U.S., this transition began several years ago when this country started to consume petroleum faster than it was being discovered. Completing this transition will require major adjustments because of higher energy costs, the possibility of sporadic petroleum shortages, and the need for an accommodation between energy development and the environment.

This transition can be successfully accomplished, however, if it is effectively managed. In part, this will require continued efforts to conserve energy and to accomplish, where feasible, the substitution of other fuels in end uses now supplied by oil.

While coal and nuclear energy will play growing roles in meeting U.S. energy needs in the form of electricity, there will still be a continuing requirement for liquid and gaseous fuels over the transition period. To meet this demand, the U.S. should endeavor to maximize its conventional petroleum production and develop a viable synthetic fuels industry.

This will require a high degree of cooperation between government and the private sector. Each has a job to do in seeing the nation through the energy transition.

Above all, the nation must keep in mind the long lead times required for all types of energy development, from the development of new oil fields to the design and construction of new electricity generation capacity and synthetics plants. Accordingly, action must be taken now, in the early 1980s, if the projections in this Outlook are to be realized.